



Loureiro Engineering Associates, Inc.

November 2, 2000

Pratt & Whitney
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RDMS # 100171

**United States EPA
Region I, New England**
One Congress Street
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Boston, MA 02114-2023

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RDMS DocID 00100171

Attn: Earnest Waterman

Attn: Kim Tisa

**RE: Willow Brook Pond and Willow Pond
PCB Remediation**

Dear Mr. Waterman and Ms. Tisa:

In response to our recent conversation, we have prepared this letter to further describe our current proposal to address polychlorinated biphenyl (PCB) contaminated soil and sediment within Willow Brook and Willow Brook Pond at the United Technologies Corporation (UTC), Pratt & Whitney (P&W) manufacturing facility in East Hartford, Connecticut. As discussed, UTC/P&W has developed an approach that involves the excavation and offsite disposal of soil and sediment containing total PCBs at concentrations greater than 25 parts per million (ppm), the placement of a soil and rock cap over the entirety Willow Brook and Willow Brook Pond from the Main Street culvert upstream to the outlet of the existing 108 inch diameter pipe to the upper pond, channel, and the restoration of an approximately 1-acre wetland. This approach will result in the permanent removal of the most significantly contaminated soil and sediment and, through the installation of a permanent soil and rock cap, the elimination of human health and ecological exposure pathways to the remaining soil and sediment containing less than 25 ppm total PCBs. Attachment 1 to this letter provides the basis for the determination that the proposed soil and rock cap is an adequate control to eliminate potential ecological and human exposure pathways.

The remediation will involve the excavation and offsite disposal of approximately 8,500 cubic yards of soil and sediment containing PCBs at concentrations greater than 25 ppm from within and immediately surrounding Willow Brook and Willow Brook Pond. It is anticipated that the soil and sediment will be stabilized onsite utilizing up to six percent lime by weight to eliminate free-draining liquids. Following stabilization, soil and sediment will be disposed of at a permitted offsite disposal facility. Based on our conversations, we also evaluated alternative approaches involving 1) the excavation and offsite disposal of soil and sediment containing PCBs at concentrations greater than 1 ppm and 2) culverting Willow Brook in conjunction with excavation of PCB contaminated soil and sediment exceeding 25 ppm PCB's followed by backfilling of the watercourse and wetland. The evaluation indicated that these alternatives would cost more than double the cost estimated for the approach proposed herein. In fact,



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excavation of soil and sediment to less than 1 ppm PCBs would increase the excavation volume to a total of approximately 31,000 cubic yards.

The proposed excavation program will progress from upstream to downstream within Willow Brook Pond and Willow Brook. The approximate horizontal limits of the soil and sediment removal activities are presented on Figure 1. Based on the prior investigations, it is anticipated that an average of 2 to 3 feet of sediment will be removed from Willow Brook Pond and up to 4 feet of sediment will be removed from the wetland north of Willow Brook. Confirmatory soil samples collected during the remediation will provide the final horizontal and vertical limits of "hot spot" excavation.

The remediation approach also involves the demolition and offsite disposal of the existing process water facility, the removal and offsite disposal of an underground oil/water separator, and the excavation and offsite disposal of impacted soil in the vicinity of the oil/water separator. The location of the process water facility and oil/water separator are shown on Figure 1. All construction demolition debris resulting from the proposed demolition activities will be disposed of at a permitted offsite disposal facility.

Following the excavation and demolition activities, Willow Brook and Willow Brook Pond will be restored. The planned restoration activities are described in detail below and depicted on Figure 2. The site restoration involves the installation of 4 types of cap over soil and sediments remaining following excavation and removal of those containing total PCBs at concentrations greater than 25 ppm. The cap details were derived based on the anticipated stream flow velocities and considered the ultimate use of the area as a combined wetland, pond, and stream channel. The base of each consists of a non-woven geotextile, a 9-inch layer of organic rich soil, and a non-woven geotextile. This layer is referred to below as an organic-rich layer. This organic rich layer was added as a contingency to mitigate any potential for PCBs to migrate vertically upward through the proposed soil and rock cap. Each cap is described below and depicted on Figure 3.

- Within Willow Brook Pond, a 36-inch soil and stone cap is proposed (refer to Figure 3). The cap will consist of a 9 inch organic rich layer, 21 inches of process gravel, and a 6-inch layer of 4-inch stone. As the flow velocity in Willow Brook Pond is extremely low and is controlled by the dam at the outlet to the pond, the stone lining will provide adequate protection against erosion.
- Within Willow Brook (downstream of the dam), a 36-inch soil and stone gabion cap is proposed (refer to Figure 3). The cap will consist of a 9 inch organic rich layer, 15 inches of process gravel, and a 12-inch thick stone gabion armor. The 12-inch thick gabion armor has been selected based on the ability to withstand significant erosive forces without deterioration. The gabions will be installed parallel to flow and consist of a chain-link basket filled with 12-inches of stone. The stone is completely enclosed within



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the chain link enclosure and will be designed to sustain double the maximum 4-foot per second anticipated velocity in Willow Brook.

- The wetland north of Willow Brook will be restored by providing a soil and wetland sediment cap consisting of the 9 inch organic rich layer, 15 inches of process gravel, and 24-inches of wetland soil. The wetland will be revegetated with native wetland plants.
- The area of the underground oil/water separator will be provided with an engineered control to comply with the requirements of the Connecticut Remediation Standard Regulation. The engineered control will consist of a 40-mil flexible membrane liner, a geotextile drainage layer, 30-inches of granular backfill, and a 6-inch loam and seed layer.

Following restoration activities, UTC/P&W will implement two institutional controls to ensure the long-term protectiveness of the proposed remedy. The institutional controls consist of 1) a deed restriction to ensure the affected area will not be used for residential purposes and to prohibit excavation and 2) installation of a chain-link fence around the entire area to preclude access to Willow Brook and Willow Brook Pond (refer to Figure 2).

We hope the information provided in this letter serves to better describe the proposed approach and the justification for its selection. Due to the compressed time schedule for this project, we would like to discuss this proposal with you both as part of our previously scheduled meeting with Ernie on November 6, 2000. Should you have any questions or comments in advance, please feel free to contact Lauren Levine of UTC or me.

Sincerely,

LOUREIRO ENGINEERING ASSOCIATES, INC.

FOR
Jeffrey J. Loureiro, P.E., L.E.P.
President

Attachments

cc: Jim Cline, UTC
Lauren Levine, UTC

Hanna Associates, Inc. ***INTEGRATED RISK MANAGEMENT***

RISK MANAGEMENT OF WILLOW BROOK POND

I. Background on Willow Brook and Willow Brook Pond

Willow Brook is a small stream transecting the UTC/P&W facility from the northern portion of the Rentschler Airport through to the northwest portion of the current UTC/P&W operations complex. Willow Brook flows in a southwesterly direction in an open channel from the Rentschler Airport, is then hard-piped underground to the inlet of Willow Brook Pond. From the pond, Willow Brook continues as an open channel, except for a culvert under Main Street, through a mixed residential, commercial industrial area of East Hartford and eventually discharges to the Connecticut River approximately 2,500 feet from the UTC/P&W facility.

Willow Brook Pond is a man made water body located in the northern portion of the Site. In the area of the proposed remedial activities, Willow Brook and Willow Brook Pond are bordered to the north by a residential development, to the south and east by the P&W manufacturing facility complex, and to the west by Main Street. The pond, a single body of water when first created, has been modified various times through the years. Willow Brook Pond has received NPDES-permitted discharges from the UTC/P&W facility with the principal discharge being from a dilute wastewater treatment plant. Currently, the discharge is comprised of cooling water and storm water runoff from the plant area. According to the "Water Quality Classifications Map of Connecticut," published in 1987 by the CTDEP, Willow Brook has been designated as "B" by the CTDEP, indicating that is known or presumed to meet water quality criteria for recreational use, fish and wildlife habitat, agricultural and industrial supply, and navigation.

During routine draining of Willow Brook Pond in September 1997, an oil sheen was noticed seeping through the sediment. Initial sampling indicated the presence of PCBs. Subsequently, three phases of investigation of Willow Brook and Willow Brook Pond have been completed. While SVOCs and metals were detected during these investigations, remediation will be driven by PCB concentrations. UTC/P&W is in the process of completing a remediation plan. This document addresses the remedy from a risk management perspective

II. Summary of Findings

PCBs are generally distributed in the brook and pond sediments gradually decreasing in concentration in the downgradient direction. This decrease trends from > 100 ppm in the pond and wetland areas to a concentration of < 1 ppm at Main Street. PCBs were also found in the soils between the two ponds, where

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the former oil/water separator was located. The vertical extent of PCB impacts has been defined by the sampling conducted, generally achieving non-detect or concentrations < 1 ppm at depths ranging from 4 to 6 feet below grade in the off-site wetlands and 14 to 16 feet below grade in the pond area. Soil samples collected along and up the banks of the brook and ponds define the horizontal limits of PCB to non-detect or concentrations of < 1 ppm. Semi-volatile organic compounds and select metals are co-located with the elevated PCB concentrations.

Groundwater samples collected identified only two locations where PCB concentrations were above detection limits (WT-PZ-136 at 8.5 ppb and WT-PZ-139 at 0.73 ppb). Well WT-PZ-136 is located in the immediate vicinity of the former oil/water separator and locations of high PCB content in soil. Well WT-PZ-139 is adjacent to an area of elevated PCB in soils. It is expected that removal of soil and source material in these areas will address PCB in groundwater.

Surface water samples were collected from Willow Brook Pond at the pumps pumping from the larger water body and dam, and from Willow Brook downstream of Willow Brook Pond at Main Street. No PCBs were detected in any of the surface water samples collected.

III. Risk Management Strategy

Appropriate response actions must be implemented to manage PCB-impacted sediments and wetlands associated with Willow Brook Pond to assure that the area does not pose a chronic human health and/or ecological concern. The potential PCB exposures to both humans and ecological receptors are associated with direct contact. Thus, the risk management strategy of the PCB-impacted Willow Brook Pond area must result in limiting, if not preventing, future exposures.

With respect to human exposure, the response action should incorporate an approach to eliminate the direct exposure pathway by either removal of PCB-impacted soils and/or by providing a barrier to soil and sediment exposures. This may be achieved by placement of clean fill over the surficial soils or excavation of PCB contaminated soil to a prescribed depth and replacement with clean fill. In most cases, removal of soils and sediments is the preferred option particularly within surface waters and adjacent floodplains and wetlands.

Typically, exposures to surficial soils are considered to extend to at least 6-inches in depth but may also extend to 18-inches. Generally, the top 6-inches is associated with the most biological active layer that may be mixed due to vertebrate and invertebrate activity, e.g. earthworms. Due to the mixing within the biologically active layer, which may be considered in some cases to extend to

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a depth of 12-18 inches, PCBs remaining at depth may be brought to the surface thereby facilitating the direct exposure to humans.

Although Willow Brook and Willow Brook Pond are not and will not be used for recreational activity, in general human activity associated with a recreational exposure would consider surficial soils to be 6-12 inches. This depth should also be sufficient for a trespass scenario. In instances of utility installations and construction, potential worker exposure to soils at greater depths may occur.

Based on the above discussion of exposure potential, a very conservative definition of surficial soils with respect to potential non-residential human and ecological exposures associated within the Willow Brook Pond area would be considered to extend to 18 inches provided that the risk management strategy for the site be developed to incorporate institutional controls and construction management strategies in the event that future deep excavation is required.

The primary concern with respect to PCB-impacted sediments is the potential for PCB bioaccumulation in the food chain. The initial step in the bioaccumulation process is PCB bioconcentration in the benthic organisms of the sediments followed by PCB accumulation in each successive organism within the food chain. The maximum depth of this biologically active sediment layer has been demonstrated to be approximately 10 cm (Karickhof and Morris, 1985, and Matisoff et. al., 1985), with a 22-cm (8.7 inch) cover providing an effective barrier to contaminant migration due to activity within the biologically active sediment layer. This migration, often referred to as bioturbation, is primarily the result of benthic organism activity in sediments.

In addition to the need for a 9-inch cover to provide an effective barrier associated with bioturbation, the potential for flooding to result in the uncovering and migration of PCB-containing sediments and soils must also be considered. The channeling of Willow Brook Pond to serve as a major drainage control for the area increases the potential for scouring sediments and wetland soils during a large storm event. Development of the risk management approach and selection of a remedy should therefore incorporate an analysis of the barrier depths of soil and sediment required to prevent future uncovering of any potential residual PCBs remaining after the response action is implemented.

IV. Implementation of Risk Management Strategy

In light of the PCB concentrations found, UTC/P&W is developing plans to ensure exposure to PCB contaminated sediments and soils will be controlled by removing concentrations above 25 ppm and backfilling with soil and/or a rock cap over the entirety of Willow Brook and Willow Brook Pond from the underground outlet at the facility building to Main Street. The approach will result in the removal of surficial soils and sediments to a minimum of 3 feet in depth. Willow

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Brook Pond stabilization will be accomplished by laying a geotextile, a 9-inch layer of organic-rich soil, a geotextile, 21-inches of process gravel and a 6-inch layer of 4-inch stone. Stream stabilization will be accomplished by laying a geotextile, a 9-inch layer of organic-rich soil, a geotextile, 15 inches of process gravel and 12 inches of gabion channel armor. Within the wetland area, a geotextile, a 9-inch organic-rich soil layer, a geotextile, 27 inches of process gravel and 12-inches of wetland soil will be applied to the excavated wetland area. The wetland will be revegetated with native wetland plants.

As described in the previous section, excavation of sediment and wetland soils along with an engineered backfill to a depth of at least 18-inches is a conservative estimate of the depth necessary to remove current exposure routes for terrestrial/aquatic organisms and to prevent any residual PCB concentrations from being mixed with surficial soils due to biological or human activity, with the exception of deep excavation typical of utility installation or construction. Throughout Willow Brook and associated wetlands, excavation and a cap of at least 3-feet is planned. The excavation may in fact be greater in some areas since concentrations exceeding 25 ppm are to be removed. Consequently, the excavation will result in the removal of a significant mass of PCBs.

Within the wetland area, the combination barrier of an organic-rich soil, gravel and wetland soil of 3-feet cover is more than adequate to prevent direct exposure. The organic-rich soil will also serve to prevent any residual PCBs that may remain in place from infiltrating the upper layers. The inclusion of vegetative growth to prevent erosion will be effective along the bank of Willow Brook and the wetland provided a hydrologic analysis indicates high flow events will not result in erosion and sediment transport of the reconstructed wetland.

Within the stream channel, a combination barrier of an organic-rich soil, gravel and wetland soil of 3-feet cover is also more than adequate to prevent direct exposure, particularly since bioturbation is considered to result in mixing to a maximum depth of 9-inch. As in the case of the wetland, the 9-inch organic-rich soil will serve to prevent any residual PCBs that may remain in place from infiltrating the upper layers. The gravel and rock placed over the soil backfill will need to be evaluated to assure the stream bed will remain stable during flood events.

In conclusion, the depth of the excavation and cap is more than adequate to prevent current and future direct exposures provided there is no deep excavation. Consequently, institutional controls will be required. Since no utilities exist in the area to be remediated, the institutional controls simply need to prevent future installations and/or construction. Additionally, due to the need to assure the stream bed and wetland will remain stable during flood events, it is recommended that a hydrologic analysis be performed to assess the adequacy of the remedial design and backfill materials.

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References:

- Karickhoff, S.W., and K.R. Morris. 1985. Impact of Turbificid Oligochaetes on Pollutant Transport in Bottom Sediments. *Environ. Sci. Technol.* 19:51-56.
- Matisoff, G., J. Fisher, and S. Matis. 1985. Effects of Benthic Macroinvertebrates on the Exchange of Solutes between Sediments and Freshwater. *Hydrobiologia.* 122:19-33.

LINDA M. HANNA

EDUCATION

1983 Ph.D., Biomedical Engineering, University of Pennsylvania

1978 B.S., Chemistry, Moravian College

EXPERIENCE

Dr. Hanna has more than 15 years experience in environmental health sciences representing industry coalitions, facilities, and PRPs in strategizing technical and procedural approaches to meeting their complex environmental needs. Her strengths are in fostering strategic solutions through a multidisciplinary teamwork approach made feasible by her diverse technical background. Dr. Hanna has, herself, developed numerous models and utilized models for fate and transport analyses in various media and multimedia transport, performed analyses to assess dose-response relationships, toxicological assessments, and developed methods to performed pharmacokinetic modeling and cross-species extrapolation. Additionally, she has led large investigations necessitating the need to utilize outside experts and other consulting firms to address clients' needs while maintaining strong inhouse technical team. Finally, Dr. Hanna has also represented clients in negotiations with agencies and in litigation support, as well as before expert panels including the EPA Science Advisory Board and other similar scientific forums.

Prior to consulting, Dr. Hanna served on the faculty at The Johns Hopkins University where she established an inhalation toxicology program, trained doctoral students and taught environmental and biological transport modeling in both graduate and undergraduate programs. She maintains an adjunct faculty position at The Johns Hopkins University. As President of Hanna Associates, Inc. – Integrated Risk Management (IRM), she is responsible for providing technical oversight in the areas of exposure assessment, ecological and human health risk assessment, and fate and transport analyses. She provides strategic and project scoping for all major projects and is central to the Quality Assurance/Quality Control program at IRM. The following represents a sampling of her career activities.

Exposure Assessment of Environmental Contaminants

- ***Site Investigation and NRD Preparation.*** Responsible for site assessment, conceptualization of interim actions, studies in anticipation of an NRD, and source allocation studies in a PRP arbitration/litigation. Represents the client as the technical lead to the agency for all phases of the investigation and remedy selection as well as to the NRD trustees in the NRD. Dr. Hanna has also been a principal contact with public officials throughout the process.

- ***Multipathway Risk Assessment.*** Represented the client as the risk assessment technical lead at all agency meetings and negotiated the focus of the risk assessment and methodologies to be used. Coordinated the risk assessment of the 800-acre Resource Conservation and Recovery Act (RCRA) site requiring the consideration of multiple migration routes and exposure pathways. In the process, performed a review of a 10-year historical database analyzed by numerous analytical methods which resulted in a 50% reduction in the contaminants of concern.
- ***Radiocunclide NESHAPs Analysis.*** Managed the Radionuclide NESHAPs analysis in which the emissions characterization (including stack configuration), meteorological data, dosimetry and toxicology were reassessed for the purpose of challenging the emissions limits established for a facility. The reanalysis was submitted to EPA as a part of a legal suit brought by the facility against the agency because the limits imposed unnecessary operating restrictions preventing the facility from maintaining and perhaps increasing production.
- ***Expert Testimony-Risk Assessment.*** Prepared litigation support materials for expert testimony. Prepared to assist the jury in understanding the exposure and comparative risk related to the jury's geographic location and the specific concern that was the subject of the litigation.
- ***Dioxin Litigation Support.*** Responsible for review of the transport and fate model, the basis for the bioaccumulation factor used in the assessment and the method of risk assessment used to establish the allowable groundwater dioxin flux to a water body. The flux level was to be used to establish groundwater monitoring triggering levels which were the subject of the litigation with the EPA.
- ***Model Development.*** Developed a fate and transport approach to establish monitoring criteria for groundwater monitoring wells adjacent to major rivers. The model was submitted during the negotiations to support the proposed monitoring network following the RCRA closure.
- ***Fruit/Vegetable Ingestion.*** Managed an exposure analysis of individuals ingesting homegrown fruits and vegetables and presented the results to the agency via reports and several agency meetings/presentations. The effort included development and implementation of a field sampling plan and the evaluation of geochemical parameters, uptake of inorganics in fruits and vegetables, and ingestion rate. In addition, managed the performance of a Monte Carlo stochastic analysis of this exposure pathway. The analysis eventually resulted in EPA altering their plans to force a wider assessment of the pathway and, potentially, remedial actions in residential backyards.

Risk Assessment

- ***Nationwide Risk Assessment.*** Oversaw the development of a methodology and the performance of the analysis to assess the nationwide impact of short-term SO₂ exposures in the vicinity of non-utility industries (approximately 5,000 facilities). Presented the methodology to EPA's SAB and maintained contact with OAQPS during the model development. A report, prepared for the American Mining Congress, was submitted to EPA for its consideration of a need to establish a short-term 5-minute National Ambient Air Quality Standard (NAAQS).
- ***Peer Review.*** Provided peer review of Department of Energy (DOE) risk assessment guidance and methods as a member of the Consortium for Environmental Risk Evaluation.
- ***RCRA/CERCLA Risk Assessments.*** Project manager of numerous Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and RCRA Phase I and Phase II risk assessments as well as state-led sites. The focus is on the use of current science to ascertain more realistic assessment of the risk driving exposures on the site. The following disciplines are used in developing an interdisciplinary approach: transport modeling, geochemistry, statistics, analytical chemistry, and population behavior. Often represent the client during agency negotiations and public meetings.
- ***RFI Phase II Investigation.*** Developed a unique approach for a RCRA RFI Phase II Investigation as a member of a project team. The approach coordinated the use of screening methods, corrective measures, modeling needs, and preliminary remediation goals to focus on areas of concerns, chemicals of concern, exposure pathways, and extent of areal investigation. The integration of the remedial engineers, risk assessors, and site investigators streamlined the efforts towards assessment and closure.
- ***RI/FS Support.*** Provided guidance in the performance of remedial investigation/feasibility study (RI/FS) activities in support of risk assessment and ROD conceptualization for numerous CERCLA sites. An example of this activity is the demonstration that maximum risk reduction of groundwater treatment occurs in the first 5–10 years because of the high removal efficiency of the most toxic compounds thereby justifying limited groundwater treatment.
- ***Expert Testimony.*** Expert witness on risks associated with property at the time of client's purchase. Reviewed all data known to the seller and to the purchaser; evaluated risks based on current risk assessment guidance as well as that in effect during the time of sale. This type of assessment has been performed for several clients.

Toxicology/Ecology

- ***Ecological Investigation/Habitat Evaluation.*** A facility is currently undergoing RCRA Corrective Actions during which time part of the land is being offered for sale. Ecological concerns are now a focus of an accelerated program to allow the land to be sold. Ecological investigative work has been conducted to assess potential ecological impacts due to chemical contaminants found on site. The investigation involved a screening of chemicals of concern (COCs) against current ecological screening levels in order to assess the extent of contamination and to see which COCs needed further addressing for possible corrective action. In conjunction with the COC evaluation, this investigation involved a habitat assessment that was conducted to document the variety of habitats found on site, and species identification to ground truth the COC evaluation.
- ***Ecological Assessment.*** Conceptualized and performed an ecological investigation of several terrestrial habitats and a river delta region. Negotiated the study with EPA on behalf of the client. The delta region study required establishing sediment levels of ecological concern and developing a statistical approach to allow comparison of the area of concern to reference locations and differing depositional zones as well as covariates. The results were used in followup reports and agency meetings to justify a no further action with respect to ecological receptors.
- ***Estuarine Criteria.*** Negotiated with the state on the methodology and species to be used in developing site-specific criteria for an estuarine site because neither freshwater nor marine criteria were applicable. The protocol development was negotiated so as to provide flexibility on the species as well as the procedures to be used because of the need to consider a wide range of salinities.
- ***PCB Modeling.*** Performed an analysis of historical data regarding polychlorinated biphenyl (PCB) transport, sediment concentrations, and fish tissue levels in an estuarine environment to correlate to known releases from a waste site. Developed a conceptual model for determining the extent of the hydrophobic release in the estuarine system, in which the tidal flow and salinity affect the dispersion of the compound, for comparison to historic sampling locations.
- ***ATSDR Profiles.*** Oversaw a large contract involving the research and writing of toxicological profiles for the Agency for Toxic Substances and Disease Registry.
- ***Pharmaceutical Impact.*** Evaluated the potential impact of a new pharmaceutical agent on environmental receptors based on extensive laboratory studies. The assessment was incorporated into a new animal drug application to the Food and Drug Administration (FDA) and was received as a model for future FDA applications. The analysis resulted in the request to present before a specially convened FDA panel in May 1994 to evaluate the use of antibiotics in herds.

- **Historical Review.** Provided several historical perspectives on the state-of-the-art knowledge of chemical toxicity and on recognized special handling needs within industry; reviewed documents and depositions for litigation support; prepared as an expert witness but evidence uncovered during the process resulted in settlement.
- **Reviewer for EPA.** Served as External Reviewer for EPA documents including, "A Methodology for Estimating Population Exposures from the Consumption of Chemically Contaminated Fish."

Dose-Response Assessments and Pharmacokinetic Modeling

- **Dosimetry Project.** The recent USEPA guidance on cancer assessment (U.S. EPA, 1996) proposed an analytical framework for incorporating all relevant mechanistic information emphasizing the need to evaluate the conditions of exposure and pharmacokinetic parameters in a manner consistent with the RfC Methodology. Using the existing RfC Methodology as a platform, key mechanistic factors influencing the agent's disposition and mode of action are being developed for the gastrointestinal tract and dermal portals. Refinement of the respiratory tract models is also under development. This project is intended to result in the development a new guidance document that expands the discussion of how to incorporate mechanistic information to motivate the choice of different dose metrics for dose-response assessment. This work will set the stage for consistency and harmonization between cancer and noncancer approaches and across the oral, dermal, and inhalation routes.
- **EPA NCEA RfC/RfD Program.** Served as the project manager for a large EPA contract to evaluate methodologies for establishing toxicity values under IRIS, and review or develop IRIS submissions.
- **Animal to Human Extrapolation.** As consultant to EPA, was responsible for developing a method to extrapolate inhaled doses of soluble or reactive gases from animals to humans. Presented the analysis to several panels of expert reviewers during its development. The analysis required incorporation of default parameters to be applied to the methodology based on the analysis of available animal and human data. Specific emphasis was on gases that are moderately soluble in the respiratory tract and hence may have both respiratory effects and/or systemic effects.
- **RfC Methodology.** As consultant to EPA, evaluating all available inhalation studies to determine the appropriateness of the studies for evaluating default parameters for EPA's reference concentration (RfC) methodology and the appropriateness of the data to scale to gases with potential respiratory and/or systemic effects.

- **Fiber Toxicity.** As a consultant to private industry, assessed the available methods to evaluate fiber toxicity and dosimetry based on fiber composition, solubility and dimensions for the purpose of establishing toxicity objectives in future research programs as well as establish program in fiber development to assess potential longevity and toxicity of new fibers under consideration for production use.
- **Modeling Lung Burden.** As a consultant to a coalition, established a dosimetry model to determine the lung burden of a specific inhaled fiber from which a quantitative risk assessment was performed. The analysis incorporated parameters of the fiber dimensions and solubility in determining deposition and retention time in the lung. The analysis was combined with a dose-response analysis to evaluate potential carcinogenicity for varying lung burdens in the occupational setting.
- **Absorption of soluble pollutant gases.** As principal investigator under a National Institute of Occupational Safety and Health (NIOSH) grant, conceptualized, developed, and directed a study to predict regional absorption of soluble pollutant gases within the human respiratory tract, including a gas or vapor attached to particles. A numerical model was developed using a finite differencing approach. Developed a fluorescent spectroscopy method to measure convective mass transport coefficients.
- **Assessing EPA PM-10 Proposal.** As consultant to an industry consortium, was responsible for evaluating EPA's method for ascertaining pulmonary function decrements associated with PM-10 as stated in the recent (1995) draft PM-10 criteria document. Prepared formal response on behalf of consortium. Also evaluated the basis for the health effects of PM-10 and the dosimetry adjustments developed by EPA for the next PM-10 criteria document revision on behalf of the same consortium.
- **Model Enhancement.** Under a Whitaker Foundation grant, expanded on a NIOSH project to utilize a model for species extrapolation and to develop three-dimensional anatomic models on a CAD-CAMM using computed tomography scans as the input. In addition, the foundation expanded the grant to develop methodology for *in vivo* measurements of soluble gases in the respiratory tract.
- **Upper Airway Model.** Co-developer with Triangle Research and Development Corporation, North Carolina, of an upper airway model for use in transport studies and as an educational tool for physicians.

ACADEMIC AND ADVISORY EXPERIENCE

- Served as a faculty member at The Johns Hopkins University and a founding member of the Human Exposure Assessment Laboratory. Advisor to numerous Ph.D. candidates. Continues to maintain an adjunct faculty position.
- Was a member of the Research Advisory Review Panel of the Baltimore Integrated Environmental Management Project (1986-87).

- Editorial Board Member of Mathematical Modeling in Physiology for the American Physiological Society.

EMPLOYMENT HISTORY

1998-Present President, Hanna Associates, Inc. - Integrated Risk Management
 1993-1998 Vice President, Sciences International Inc.
 1991-1993 Manager, Risk Assessment, BCM Engineers, Inc.
 1984-1991 Assistant Professor, Dept. of Environmental Health Sciences, Johns Hopkins University

SELECTED PROFESSIONAL PUBLICATIONS

Book Chapters

Hanna, L.M., R. Frank, Scherer, P.W. 1989. "Absorption of soluble gases and vapors in the respiratory system." Chapter in *A Quantitative Approach to Respiratory Physiology*. Chang, H.K., Paiva, M. eds. New York: Marcel Dekker.

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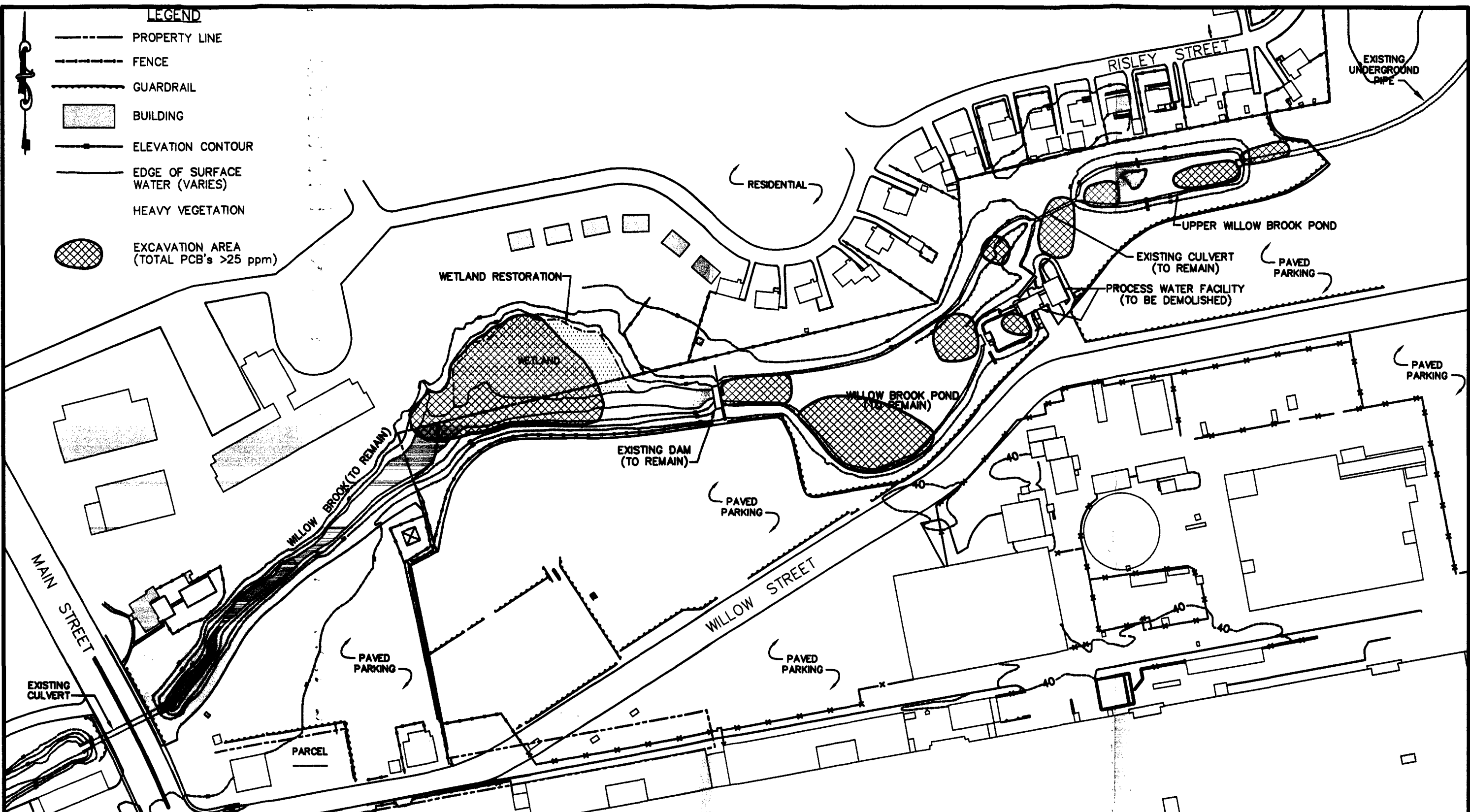
Hanna, L.M., Lou, S-R., Doyle, B.T., Zinreich, S.J. A Method of Analysis of Human Nasal Cavity Dimensions and Contour. To be resubmitted to *J. Appl. Physiol.*, July 1993.

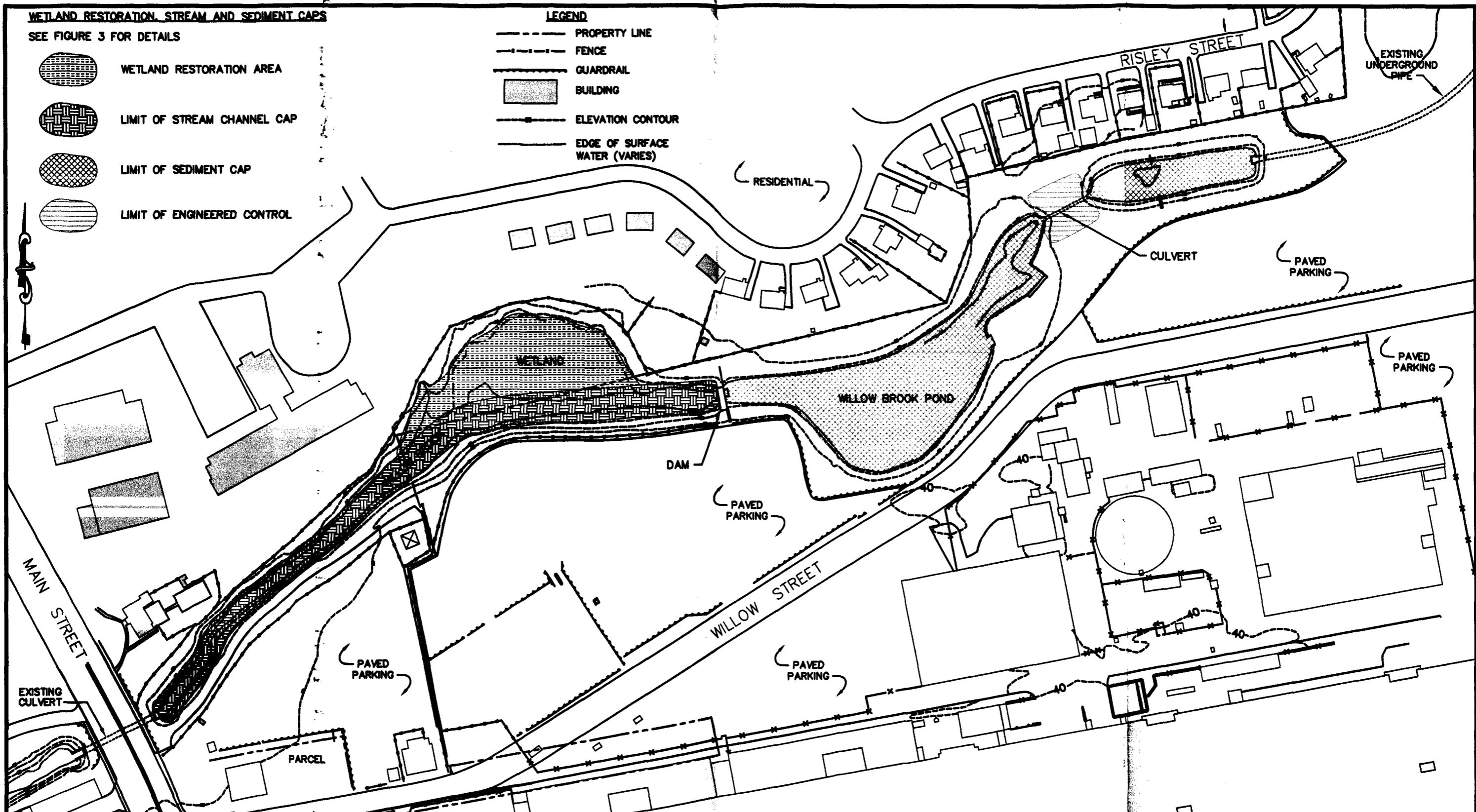
EXPERT TESTIMONY

Testimony before CASAC in August 1993 on the strengths of the scientific basis of the EPA staff recommendation to propose a short-term SO₂ standard.

Testimony before FDA in May 1994 on the potential environmental impacts of fluoroquinolones on ecological receptors.

Testimony before CASAC in April 1994 on the ongoing study to assess potential exposures to exercising asthmatics and the significance of the asthmatic response in relation to other stimuli.





NOTES:
1. BASE MAP FROM ELECTRONIC FILE OF LOUREIRO ENGINEERING ASSOCIATES, P.C. DRAWING, DATED 12/1/96 AND FROM USGS AERIAL PHOTOGRAPHY, 1994.

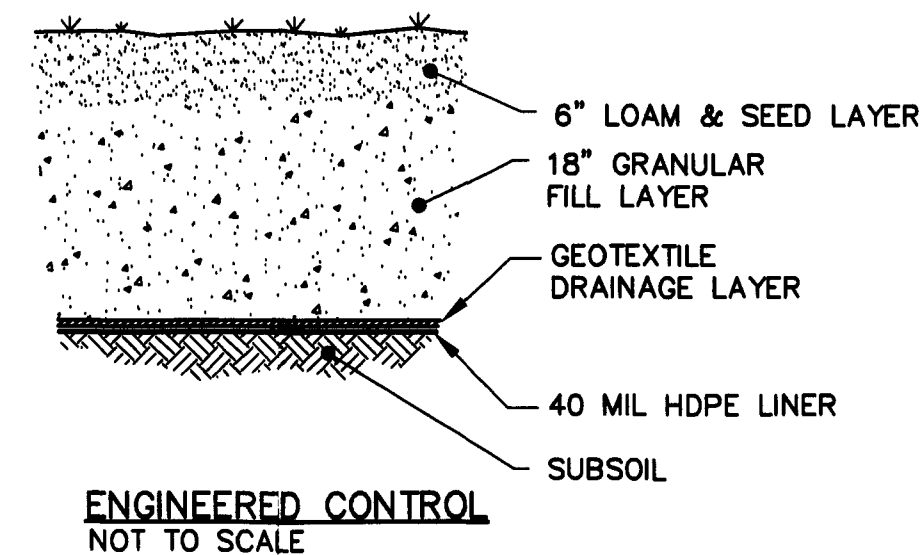
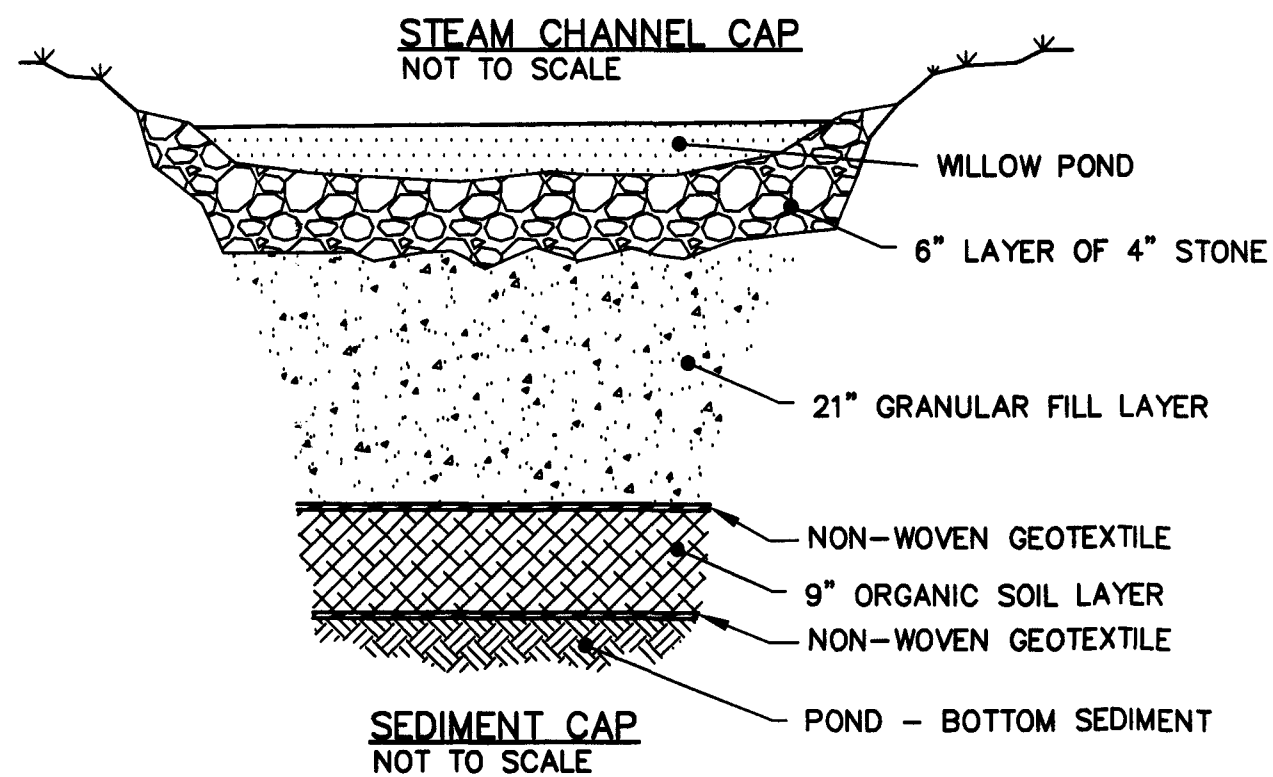
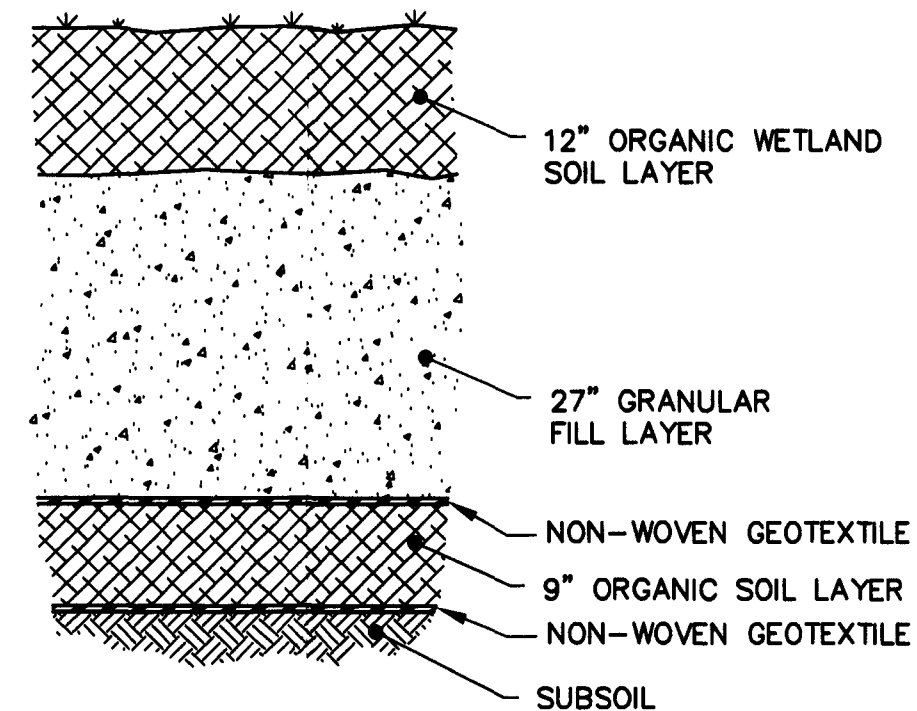
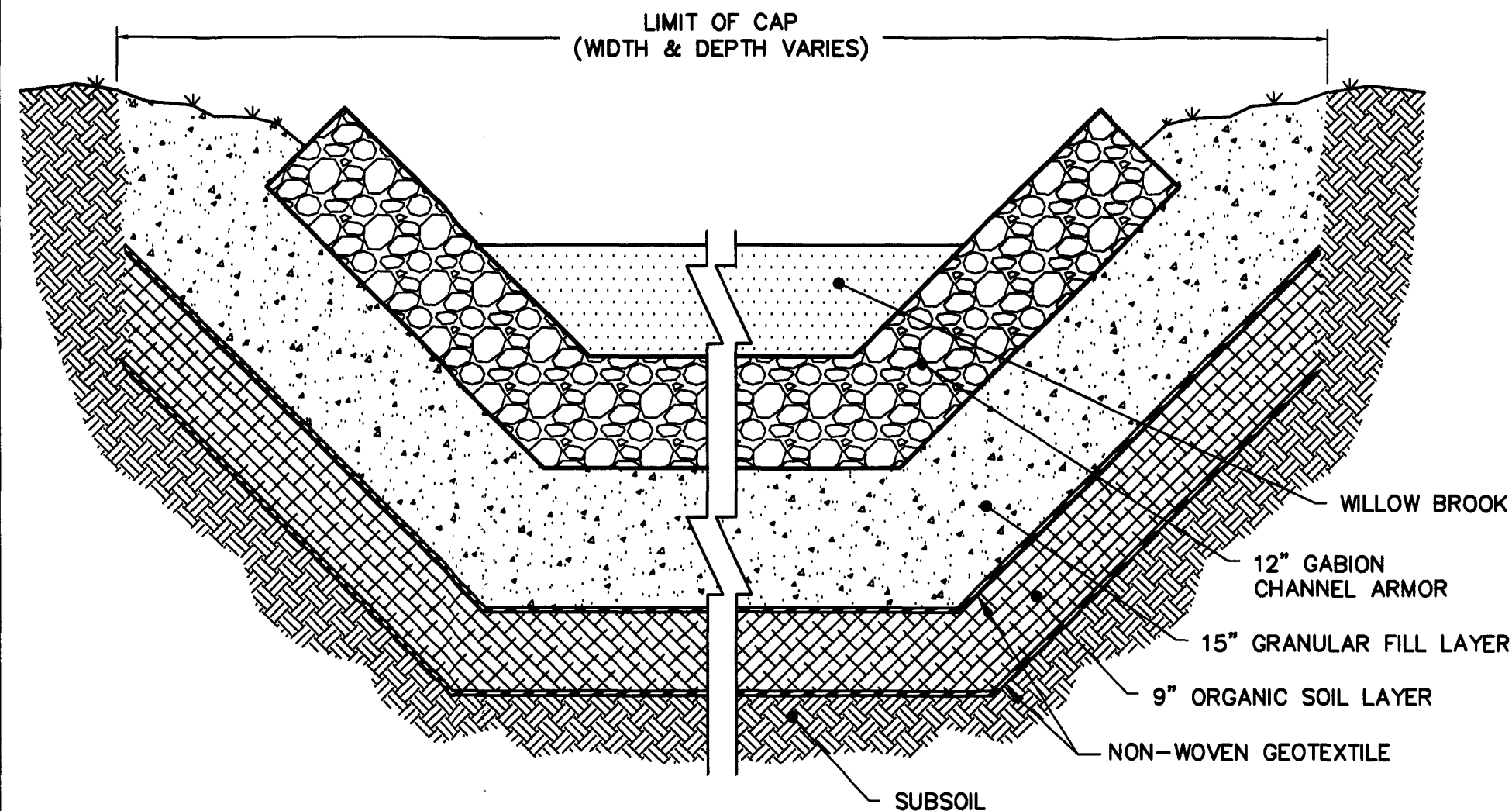
REMEDIAL ACTION WORK PLAN
UTC/P & W, Willow Brook & Willow Brook Pond
PROPOSED SITE RESTORATION

Comm.No.
88UT002.001

FIGURE 2



88UT002-FR02.dwg



REMEDIAL ACTION WORK PLAN UTCVP & W. Willow Brook & Willow Brook Pond		
PROPOSED SITE RESTORATION WETLAND RESTORATION AND CAP DETAILS		
Comm.No.	FIGURE 3	
88UT002.001		